Sharon L. Padula

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Position

Mathematician, AST Engineering Optimization

Biography

- 1973 BS Mathematics, College of Wm & Mary
- 1973 Acoustics and Noise Reduction Division
- 1977 MS Applied Science, College of Wm & Mary
- 1985 Interdisciplinary Research Office
- 1990 Structural Dynamics Division
- 1994 Fluid Mechanics and Acoustics Division
- 1999 Aerospace Systems, Concepts and Analysis Competency
- 2004 Systems Analysis and Concepts Directorate

Current work assignment

Uncertainty -based design and optimization applied to subsonic, supersonic and rotary wing vehicles

Prior research projects and areas of interest

Combinatorial Optimization

Ms. Padula is a noted expert in combinatorial optimization methods like genetic algorithms, and simulated annealing. Starting in 1990, she found the best locations for damping struts on the CSI Evolutionary Model as part of a study on the dynamics of large space structures. Later, she worked with the Active Structural Acoustic Control (ASAC) team to find the best location for piezo-electric actuators and microphone sensors on a composite cylinder laboratory test. The success of the ASAC laboratory test influenced the placement of mechanical dampers on a joint Raytheon-NASA Beech 1900D flight test. More recently, Ms. Padula studied novel control systems for stealthy aircraft as part of the Morphing program. Optimal placement of actuators and sensors was one key to the success of each of these applications.

Uncertainty-Based Methods

A relatively new area for System Analysis is uncertainty-based methods (UBM). Sharon Padula initiated interest in this area by organizing a 1997 ICASE workshop on the subject. Next, she advocated UBM research, brought two different post-docs to Langley and showed the application of UBM to aerodynamic shape optimization and crashworthy airframe design. She is currently working on Optimization under Uncertainty applied to aircraft wing structures.

Variable Fidelity Framework

Ms. Padula's interest in variable-fidelity frameworks started with the Aircraft Noise Prediction Program (ANOPP). In 1981, she received a Group Achievement Award for developing, implementing, and applying ANOPP. She has developed her own optimization frameworks and has demonstrated the power of commercial frameworks such as iSIGHT and CenterLink. She is currently using this expertise to develop a ModelCenter framework for use by system analysts at ASAB and an iSIGHT framework for aircraft noise research.

Publications

1. FORMAL PUBLICATIONS

1.1. Padula, Sharon L.; and Liu, Chen-Huei: *Numerical Study of Sound Propagation in a Jet Flow.,* NASA TN D-8012, September 1975.

1.2. Yen, D. H. Y.; Maestrello, L; and Padula, S. L.: *On an Integro-Differential Equation Model for the Study of the Response of an Acoustically Coupled Panel.,* Progress in Astronautics and Aeronautics, vol. 45, edited by Martin Summerfield, MIT Press, Cambridge, Mass., 1976, pp. 335-350, 1976.

1.3. Padula, S. L. ; and Liu, C. H.: *Acoustic Scattering of a Point Source by a Moving Prolate Spheroid.,* AIAA J., vol. 16, no. 6, June 1978.

1.4. Yen, D. H. Y.; Maestrello, L.; and Padula, S. L.: *Response of a Panel to a Supersonic Boundary Layer: Studies on a Theoretical Model.,* J. Sound and Vibration, vol. 71, no. 2, July 1980, pp. 271-282.

1.5. Padula, S. L.; and Block, P. J. W.: *Predicted Changes in Advanced Turboprop Noise with Shaft Angle of Attack.,* J. Propulsion and Power, vol. 1, no. 5, September-October 1985, pp. 381-387.

1.6. Padula, S. L.: *Subsonic Propeller Noise Module.,* In Aircraft Noise Prediction Program Theoretical Manual - Propeller Aerodynamics and Noise. Eds., Zorumski, W. E.; and Weir, D. S. NASA TM 83199, Part 3, June 1986, Chapter 11.1, pp. 11.1-1 through 11.1-41.

1.7. Padula, S. L.: *Transonic Propeller Noise Module.,* In Aircraft Noise Prediction Program Theoretical Manual - Propeller Aerodynamics and Noise. Eds., Zorumski, W. E.; and Weir, D. S. NASA TM 83199, Part 3, June 1986, Chapter 11.2, pp. 11.2-1 through 11.2-14.

1.8. Farassat, F.; Padula, Sharon L.; and Dunn, M. H.: *Advanced Turboprop Noise Prediction Based on Recent Theoretical Results.,* J. Sound and Vibration, vol. 119, no. 1, November 1987, pp. 53-79.

1.9. Padula, S. L.; and Sobieszczanski-Sobieski, J.: *A Computer Simulator for Development of Engineering System Design Methodologies.,* Proceedings of the ASME press, Boston, Mass., August 17-20, 1987, pp. 147-161. TM-89109, February, 1987.

1.10. Padula, S. L.; Adelman, H. M.; Bailey, M. C.; and Haftka, R. T.: Integrated Structural Electromagnetic Shape Control of Large Space Antenna Reflectors. AIAA Journal, Volume 27, No. 6, June 1989, p. 814-819.

1.11. Padula, Sharon; Sandridge, Chris; Walsh, Joanne; and Haftka, Raphael: *Integrated Controls-Structures Optimization of a Large Space Structure,* Computers & Structures, Volume 42, No. 5, pp 725-732, December 1990.

1.12. Padula, S. L.; James, B. B.; Graves, P. C.; and Woodard, S. E., *Multidisciplinary Optimization of Controlled Space Structures Using Global Sensitivity Equations,*, NASA TP 3130, November 1991.

1.13. Haftka, R. T.; Sobieszczanski-Sobieski, Jaroslaw; and Padula, S. L.: *On Options for Interdisciplinary Analysis and Design Optimization,* Structural Optimization Journal, Vol. 4, No. 2, June 1992, pp. 65-74.

1.14. Padula, S. L.; and Sandridge, C. A.: *Passive/Active Strut Placement by Integer Programming,* Topology Design of Structures, Bendsoe and Mota Soares (ed) Kluwer

Academic Publishers, 1993, pp 145-156.

1.15. Kincaid, R. K.; Laba, K. E.; and Padula, S. L.: *Quelling Cabin Noise in Turboprop Aircraft via Active Control.* Journal of Combinatorial Optimization, Vol. 1, No. 3 1997, pp. 229-250.

1.16. Padula, S. L.; and Stone, S. C.: *Parallel Implementation of Large Scale Structural Optimization.* Structural Optimization, Vol. 16, No. 2-3, October 1998, pp. 176-185.

1.17. Kincaid, R. K.; and Padula, S. L.: *Actuator Selection for the Control of Multi-Frequency Noise in Aircraft Interiors.* Proceedings of the 2nd International Conference on Metaheuristics. Voss (ed) Kluwer Academic Publishers, 1998.

1.18. Zang, T. A.; Hemsch, M. J.; Hilburger, M. W.; Kenny, S. P.; Luckring, J. M.; Maghami, P.; Padula, S. L.; and Stroud, W. J.: *Needs and Opportunities for Uncertainty-Based Multidisciplinary Design Methods for Aerospace Vehicles,* NASA TM-2002-211462, July 2002.

1.19. Li, W.; Huyse, L.; and Padula, S.: *Robust Airfoil Optimization to Achieve Drag Reduction Over a Range of Mach Numbers.* Structural and Multidisciplinary Optimization, Vol.24, No. 1, August 2002, pp. 38-50.

1.20. Huyse, Luc; Padula, Sharon; Lewis, R. Michael; and Li, Wu: *A Probabilistic Approach to Free-Form Airfoil Shape Optimization Under Uncertainty.* AIAA Journal, Vol. 40, No. 9, September 2002, pp. 1764-1772.

1.21. Li, Wu; and Padula, Sharon: *Using High Resolution Design Spaces for Aerodynamic Shape Optimization Under Uncertainty*, NASA TP-2004-213003, March 2004.

1.22. Li, Wu; and Padula, Sharon: *Approximation Methods for Conceptual Design of Complex Systems.* Approximation Theory XI: Gatlinburg 2004, Chui, Neamtu, and Schumaker (ed) Nashboro Press, Brentwood, TN, 2005, pp. 241-278.

1.23. Padula, Sharon; Gumbert, Clyde; and Li, Wu: *Aerospace Applications of Optimization Under Uncertainty.* Optimization and Engineering Journal, accepted for publication.

2. REFERENCEABLE ORAL PRESENTATIONS

2.1. Padula, Sharon L.; and Liu, Chen-Huei: *A Computer-Oriented Approach to the Propagation of Sound Through a Non-uniform Jet Stream.,* Presented at the 88th Meeting of the Acoustical Society of America, St. Louis, Mo., November 4-8, 1974, NASA TMX-71941.

2.2. Yen, D. H. Y.; Maestrello, L; and Padula, S. L.: *On an Integro-Differential Equation Model for the Study of the Response of an Acoustically Coupled Panel.,* Presented at the AIAA 2nd Aeroacoustics Conference, Hampton, Va., March 24-26, 1975.

2.3. Padula, S. L.; and Liu, C. H.:: *Acoustic Scattering of Point Source by a Moving Prolate Spheroid.,* Presented at the 4th Aeroacoustics Conference, Atlanta, Ga., October 3-5, 1977. AIAA Paper no. 77-1326.

2.4. Padula, Sharon L.: *Prediction of Noise Constrained Optimum Takeoff Procedures.,* Presented at the AIAA 6th Aeroacoustics Conference, June 4-6, 1980, Hartford, Conn., AIAA Paper no. 80-1055.

2.5. Raney, J. P.; Padula, S. L.; and Zorumski, W. E.: *NASA Progress in Aircraft Noise Prediction.,* Presented at Aircraft Operating Problems Conference, LaRC, Hampton, Va., November 4-6, 1980, NASA CP-2170.

2.6. Zorumski, W. E.; Raney, J. P.; and Padula, S. L.: *NASA's Aircraft Noise Prediction Program.,* A seminar presented at the AIAA 6th Aeroacoustics Conference, Hartford, Conn., June 4-6, 1980, NASA TM-81915.

2.7. Padula, S. L. ; and Block, P. J. W.: *Predicted Changes in Advanced Turboprop Noise with Shaft Angle of Attack.,* Presented at the 9th Aeroacoustics Conference, Williamsburg, Va., October 15-17, 1984. AIAA Preprint no. 84-2327.

2.8. Padula, S. L. ; and Block, P. J. W.: *Acoustic Prediction Methods for the NASA Generalized Advanced Propeller Analysis System (GAPAS).,* Presented at the AIAA/ NASA General Aviation Technology Conference, LaRC, July 10-12, 1984. AIAA Paper no. 84-2243.

2.9. Adelman, Howard M.; and Padula, Sharon L.: *Integrated Thermal Structural Electromagnetic Design Optimization of Large Space Antenna Reflectors.,* Presented at AIAA/ASME/ASCE/AHS 27th Structures, Structural Dynamics, and Materials Conference, San Antonio, Tx., May 19-21, 1986. NASA TM-89110.

2.10. Padula, S. L. ; Adelman, H. M. ; and Bailey, M. C.: *Integrated Structural Electromagnetic Optimization of Large Space Antenna Reflectors.,* Presented at the AIAA/ASME/ASCE/AHS 28th Structures, Structural Dynamics, and Materials Conference, Monterey, Calif., April 6-8, 1987. AIAA Paper No. 87-0824-CP.

2.11. Young, Katherine C.; Padula, Sharon L.; and Rogers, James L.: *A Strategy for Reducing Turnaround Time in Design Optimization Using a Distributed Computer System.,* Presented at the 1988 ASME Design Technology Conferences - The Design Automation Conference, Kissimmee, FL, Sept 25-28,1988. Advances in Design Automation-1988. S.S. Rao (ed) pp. 81-88 and NASA TM-101519

2.12. Padula, Sharon L.; Sandridge, C. A.; Haftka, R. T.; and Walsh, J. L.: *Demonstration of Decomposition and Optimization in the Design of Experimental Space Systems,* Presented at the Second NASA/Air Force Symposium on Recent Advances in Multidisciplinary Analysis and Optimization, Hampton, VA., Sept. 28-30, 1988.

2.13. Padula, S. L.; Sandridge, C. A.; Haftka, R. T. ; and Walsh, J. L.: *Decomposition and Optimization in the Design of Experimental Space Systems.,* 2nd NASA/Air Force Symposium on Recent Experiences in Multidisciplinary Analysis and Optimization, Hampton, VA, Sept. 28-30, 1988.

2.14. Rogers, James L.; and Padula, Sharon L.: *An Intelligent Advisor for the Design Manager.,* Proceedings of the First International Conference on Computer Aided Optimum Design of Structures, Southampton, England, June 1989, pp 169-177. Also TM 101558.

2.15. Woodard, S. ; Padula, S.; Graves, P.; and James, B.: *A Multidisciplinary Approach to Optimization of Controlled Space Structures.,* Collection of Technical Papers of the Third Air Force/NASA Symposium on Recent Advances in Multidisciplinary Analysis and Optimization, San Francisco, CA., Sept. 24-26, 1990.

2.16. Kincaid, Rex K.; and Padula, Sharon L.: *Minimizing Distortion and Internal Forces in Truss Structures by Simulated Annealing,* Presented at 31st AIAA/ASME/ASCE/AHS/ASC SDM Conference, Long Beach, CA., April 2-4, 1990. AIAA Paper No. 90-1095.

2.17. Padula, S. L.; Sandridge, C.A.; Walsh, J. L.; and Haftka, R. T.: *Integrated Controls-Structures Optimization of a Large Space Structure.,* 31st AIAA/ASME/ASCE/AHS/ASC SDM Conference, Long Beach, CA, April 2-4, 1990, AIAA Paper No. 90-1058.

2.18. Padula, Sharon L.; and Polignone, Debra A.: *New Evidence Favoring Multilevel Decompositions and Optimization.,* Collection of Technical Papers of the Third Air Force/NASA Symposium on Recent Advances in Multidisciplinary Analysis and Optimization, San Francisco, CA., Sept. 24-26, 1990.

2.19. Padula, Sharon L.; and Sandridge, Chris A. *Active Strut Placement Using Integer Programming for the CSI Evolutionary Model,* . Proceedings of the Fourth AIAA/Air Force/NASA/OAI Symposium on Multidisciplinary Analysis and Optimization, Cleveland, OH, Sept. 21-23, 1992, AIAA Paper No. 92-4787.

2.20. Padula, Sharon L.; and Sandridge, Chris A. *Passive /Active Strut Placement by Integer Programming,* . NATO Advanced Research Workshop on Topology Design of Structures, Sesimbra, Portugal, June 20-26, 1992.

2.21. Padula, Sharon L.: *Progress in Multidiscplinary Design Optimization at NASA Langley.* SIAM Annual Meeting, Philadelphia, PA, July 12-16, 1993. Also NASA TM 107754.

2.22. Padula, Sharon L.; and Kincaid, Rex R.: *Aerospace Applications of Integer and Combinatorial Optimization.* SIAM Annual Meeting, Charlotte, NC, October 23-26, 1995. Also NASA TM 110210.

2.23. Palumbo, D. L.; Padula, S. L.; Lyle, Karen; Cline, John; and Cabell, R. H.: *Performance of Optimized Actuator and Sensor Arrays in an Active Noise Control System.* Second AIAA/CEAS Aeroacoustics Conference, State College, PA, May 1996. Also AIAA 96-1724.

2.24. Padula, S. L.; Alexandrov, N.; and Green, L. L.: *MDO Test Suite at NASA Langley Research Center.* Sixth AIAA/USAF/NASA/ISSMO Symposium on Multidisciplinary Analysis and Optimization, Bellview, WA, September 4-6, 1996. Also AIAA 96-4028.

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2.26. Padula, S. L.: *MDO Test Suite on the World Wide Web.* Second World Congress of Structural and Multidisciplinary Optimization, Zakopane, Poland, May 26-30, 1997.

2.27. Kincaid, Rex K.; and Padula, Sharon L.: *Actuator Selection for Control of Multi-Frequency Noise in Aircraft Interiors.* Second Metaheuristics International Conference, July 21-24, 1997.

2.28. Wlezien, R. W.; Horner, G. C.; McGowan, A. R.; Padula, S. L.; Scott, M. A.; Silcox, R. J.; and Simpson, J. O.: *The Aircraft Morphing Program.* Presented at SPIE's 5th Annual International Symposium on Smart Structures and Materials, San Diego, CA, March 1-5, 1998.

2.29. Padula, S. L.; Palumbo, D. L.; and Kincaid, R. K.: *Optimal Sensor/Actuator Locations for Active Structural Acoustic Control.* 39th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Long Beach, CA, April 20-24, 1998, AIAA Paper No. 98-1865.

2.30. Wlezien, R. W.; Horner, G. C.; McGowan, A. R.; Padula, S. L.; Scott, M. A.; Silcox, R. J.; and Simpson, J. O.: *The Aircraft Morphing Program.* 39th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Long Beach, CA, April 20-24, 1998, AIAA Paper No. 98-1927.

2.31. Padula, S. L.; and Kincaid, R. K. : *Applications of Combinatorial Optimization for Sensor and Actuator Placement*.. Third World Congress of Structural and Multidisciplinary Optimization, Amherst, N. Y., May 17-20, 1999.

2.32. Padula, S. L.; and Kincaid, R. K.*: Optimization Strategies for Sensor and Actuator Placement*.. NASA TM-209126, April 1999.

2.33. Padula, S. L.; Korte, J. J.; Dunn, H. J.; and Salas, A. O.: *Multidisciplinary Optimization Branch Experience Using iSIGHT Software.* NASA TM-209714, November 1999.

2.34. Padula, Sharon L.; Rogers, James L.; and Raney, David L.: *Multidisciplinary Techniques and Novel Aircraft Control Systems.* Eighth AIAA/NASA/USAF/ISSMO Symposium on Multidisciplinary Analysis and Optimization, Long Beach, CA, September 6-8, 2000. Also AIAA 2000-4848.

2.35. Li, Wu; Huyse, Luc; and Padula, Sharon: *Robust Airfoil Optimization to Achieve Consistent Drag Reduction Over a Mach Range. NASA CR-2001-211042. Also ICASE Report No. 2001-22.*

2.36. Padula, Sharon L.; and Li, Wu: *Options for Robust Airfoil Optimization Under Uncertainty*. Ninth AIAA/ISSMO Symposium on Multidisciplinary Analysis and Optimization, Atlanta, GA, September 4-6, 2002. Also AIAA-2002-5602.

2.37. Lyle, K. H.; Padula, S. L.; and Stockwell, A. E.: *Application of Probabilistic Analysis to Aircraft Impact Dynamics.* 44th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Norfolk, VA, April 7-10, 2003, AIAA Paper No. 2003-1482.

2.38. Li, Wu; and Padula, Sharon: *Robust Airfoil Optimization in High Resolution Design Spaces.* Fifth World Congress of Structural and Multidisciplinary Optimization, Venice, Italy, May 19-23, 2003.

2.39. Li, Wu; and Padula, Sharon: *Performance Trade Study for Robust Airfoil Shape Optimization,* 21st AIAA Applied Aerodynamics Conference, Orlando, FL, June 23-26, 2003, AIAA Paper 2003-3790.

2.40. Padula, Sharon; Gumbert, Clyde; and Li, Wu: Aerospace Applications of Optimization Under Uncertainty. 4th International Symposium on Uncertainty Modeling and Analysis, College Park, MD, September 21-24, 2003.

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